Date: December 21, 2001

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 USC 371

International Application No.:	PCT/NO00/00213
International Filing Date:	June 21, 2000
Priority Date Claimed:	June 24, 1999
Title of Invention:	TOOL FOR CHANGING THE DRILLING DIRECTION WHILE DRILLING
Applicant(s) for DO/EO/US:	BAKKE, Stig

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. (X) This is a **FIRST** submission of items concerning a filing under 35 USC 371.

2. () This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 USC 371.

3. (X) This express request to begin national examination procedures (35 USC 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 USC 371(b) and PCT Articles 22 and 39(1).

4. () A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. (X) A copy of the International Application as filed (35 USC 371(c)(2))

   a) () is transmitted herewith (required only if not transmitted by the International Bureau).
   b) () has been transmitted by the International Bureau.
   c) (X) a copy of Form PCT/1B/308 is enclosed.
   d) () is not required, as the application was filed in the United States Receiving Office (RO/US).

6. () A translation of the International Application into English (35 USC 371(c)(2)).

7. (X) Amendments to the claims of the International Application under PCT Article 19 (35 USC 371(c)(3))

   a) (X) are transmitted herewith (required only if not transmitted by the International Bureau).
   b) () have been transmitted by the International Bureau.
   c) () have not been made; however, the time limit for making such amendments has NOT expired.
   d) () have not been made and will not be made.

8. () A translation of the amendments to the claims under PCT Article 19 (35 USC 371(c)(3)).

9. () An oath or declaration of the inventor(s) (35 USC 371(c)(4)).

10. (X) A copy of the International Preliminary Examination Report with any annexes thereto, such as any amendments made under PCT Article 34.

11. () A translation of the annexes, such as any amendments made under PCT Article 34, to the International Preliminary Examination Report under PCT Article 36 (35 USC 371(c)(5)).

12. () An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

13. () An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

14. (X) A FIRST preliminary amendment.
() A SECOND or SUBSEQUENT preliminary amendment.

15. () A substitute specification.

16. () International Search Report.

17. (X) International Application as published.

18. (X) The present application qualifies for small entity status under 37 C.F.R. § 1.27.

19. (X) A return prepaid postcard.

20. (X) The following fees are submitted:

				FEES
	BASIC FEE			$1,040
CLAIMS	**NUMBER FILED**	**NUMBER EXTRA**	**RATE**	
Total Claims	14 - 20 =	0 ×	$18	$0
Independent Claims	1 - 3 =	0 ×	$84	$0
Multiple dependent claims(s) (if applicable)			$280	$0
	TOTAL OF ABOVE CALCULATIONS		$1,040	
Reduction by 1/2 for filing by small entity (if applicable). Verified Small Entity statement must also be filed. (NOTE 37 CFR 1.9, 1.27, 1.28)			$520	
	TOTAL NATIONAL FEE			$520
	TOTAL FEES ENCLOSED			$520
		amount to be refunded:		$0
		amount to be charged:		$0

21. (X) The fee for later submission of the signed oath or declaration set forth in 37 CFR 1.492(e) will be paid upon submission of the declaration.

22. (X) A check in the amount of $520 to cover the above fees is enclosed.

23. () Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40 per property.

24. (X) The Commissioner is hereby authorized to charge only those additional fees which may be required, now or in the future, to avoid abandonment of the application, or credit any overpayment to Deposit Account No. 11-1410.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

James W. Ausley
Reg. No. 49,076
Customer No. 20,995

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	BAKKE, Stig	) Group Art Unit Unknown
Appl. No.	:	Unknown	)
Filed	:	Herewith	)
For	:	TOOL FOR CHANGING THE DRILLING DIRECTION WHILE DRILLING	)
Examiner	:	Unknown	)

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to examination, please amend the above referenced application as follows:

IN THE ABSTRACT:

Please delete the abstract and insert the following amended abstract:

Abstract of the Disclosure

A tool adapted for changing the direction of drilling during drilling. The drilling equipment used in the drilling includes a drill string, a bent sub, a drill motor, and a drill bit. The tool is positioned between the drill string and the bent sub, includes housing elements connected to one another, and has a passage for drilling fluid. The tool can be activated for rotation of the bent sub so that the direction of drilling is changed in an infinitely variable manner. The tool includes a valve adapted for choking the passage so that the tool can be activated for rotation, a piston adapted for providing the rotation after passage has been choked, and sets of cooperating guides adapted for forced guiding of the rotation. The guides can be formed by twisted splines formed in the wall of the passage and in the wall of the opposite piston.

Appl. No. : **Unknown**
Filed : **Herewith**

IN THE SPECIFICATION:

Please amend the specification as follows:

TOOL FOR CHANGING THE DRILLING DIRECTION WHILE DRILLING

Related Applications

This application claims the benefit of the Norwegian application 19993138 filed June 24, 1999 and the international application PCT/NO00/00213 filed June 21, 2000.

Background of the Invention

Field of the Invention

The invention relates to adapted for changing the drilling direction while drilling with drilling equipment, which preferably comprises a drill string,such as coiled tubing, a bent sub, drilling motor and drill bit.

Description of the Related Art

During directional drilling of a formation in the ground, e.g. in horizontal drilling of a well, it is common to use drilling equipment, which comprises a drill string, bent sub and drill bit. The drill string may be formed of coiled tubing, and the drill bit may be hydraulically driven by the fluid circulating in the drill string. The drilling direction is changed through rotation of the bent sub, and the rotation is effected by the tool which is positioned between the lower end of the drill string and the bent sub. In known tools the rotation cannot be infinitely variable, but has to be done in invariable angular turns in the range of 15-20 degrees. This means that the drilling direction cannot be changed with the desirable accuracy. Another drawback of known tools is that the admission of the drill bit will have to be reduced to allow rotation of the bent sub. The consequence of this may be that the drill bit loses its grip in the ground formation, so that instead of completing its rotation, the bent sub will return to its initial position. This is a condition which complicates and moreover delays the work of changing the drilling direction.

Summary of the Invention

The main object of the present invention is to provide a whereby the rotation of the bent sub may be carried out in an infinitely variable manner. Other objects are that the rotation should

take place by full admission of the drill bit, and the rotation should take place at a speed which allows the measuring equipment to provide measurement results which are in accordance with the actual rotation. Thereby the drilling direction could be changed without the drawbacks mentioned above. Moreover, the tool will be somewhat easier to operate and provide greater precision during rotation than what has been normal. This has been realized through the present adapted for changing the drilling direction during drilling. The drilling equipment used in the drilling, preferably comprises a drill string, such as coiled tubing, a bent sub, drill motor and drill bit. Further the tool is positioned between the drill string and the bent sub, comprises housing elements connected to one another, has a passage for, among other things, fluid such as drilling fluid, and may be activated for rotation of the bent sub, so that the direction of drilling is changed. The particular about the invention is that the tool is provided with means, whichare adapted so that the rotation can be infinitely variable. The means are provided in the through passage of the tool, and comprises a valve arranged to choke the passage, so that the tool can be activated for the rotation, a piston adapted for providing the rotation after the through passage has been choked, and sets of cooperating guides adapted for forced guiding of the rotation. The guides are formed in the wall of the through passage, or in the opposite wall fo the piston. Other details of the invention will appear from the dependent Claims and the following part of the specification.

Brief Description of the Drawings

Referring to the appended set of figures, a preferred, but non-limiting embodiment of the invention will be explained,

<u>Detailed Description of the Preferred Embodiment</u>

In Figs. 2-4 the tool has been divided into two sections for reason of exposition, and the reference numerals have been distributed among the figures, so that the reference numerals of one figure refer to the same detaiuls in the other figures.

Appl. No. : **Unknown**
Filed : **Herewith**

IN THE CLAIMS:

Please amend the Claims as follows:

1. (Amended) A tool adapted for changing the direction of drilling with drilling equipment comprising a drill string, drill string sub, drilling engine and drill bit, wherein the tool is positioned between the drill string and the bent sub and wherein the tool comprises housing elements, which are connected to one another, and wherein the tool has a passage for fluid, and wherein the tool is equipped with a hydraulic piston having a set of co-operating guides where the guides are arranged for by the pistons axial displacement a forced guiding of the rotation of a first housing element with respect to the other housing elements, and where necessary fluid pressure for moving the piston is obtained by choking the fluid flow through the tool and wherein a lower intermediate housing element and a lower housing element are connected by a one direction rotatable connection.

2. (Amended) The tool of Claim 1, wherein a first set of the guides is formed in the wall of the passage, and a second set of the guides is formed in the wall of the piston opposite.

3. (Amended) The tool of Claim 2, wherein the set of guides for the forced guiding of the rotation comprise twisted splines, a first set of splines being formed in a circumferential portion of an upper intermediate housing element whereas a second set of splines is formed in a circumferential portion of the piston.

4. (Amended) The tool of Claim 3, wherein the first set of splines extends in a region at the upper end of the lower housing element, whereas the second set of splines extends essentially in the longitudinal direction of the piston.

5. (Amended) The tool of Claim 1, further comprising a valve comprising a valve seat formed at the upper end of a bore adapted to provide a passage through the piston, a valve body and a valve mechanism adapted for choking and opening the valve by increase and relief, respectively, of the fluid pressure in the tool.

6. (Amended) The tool of Claim 5, wherein the valve mechanism is formed by an upper and a lower valve body part adapted for displacement along the valve body, so that the lower valve body part can choke or open the valve, and a valve body spring, wherein the upper valve body part will displace the lower valve body part to choke the valve when the pressure of

the fluid is increased, and the valve body part spring will displace the lower valve body part in the opposite direction to open the valve by relief of the pressure of the fluid.

7. (Amended) The tool of Claim 5, wherein the piston is adapted to be displaced by the fluid supplied to the tool when the valve has been choked, or be displaced in the opposite direction by a piston spring, positioned in an upper annular space, formed in the passage of the tool, after the valve has opened.

8. (Amended) The tool of Claim 7, wherein the piston is sleeve-shaped, positioned between an upper shoulder formed in the passage of the tool, and a shoulder element located in the upper annular space and formed with a length which enables the piston to extend from the upper shoulder into the upper annular space located in an extension above a lower shoulder formed at the lower end of the upper annular space.

9. (Amended) The tool of Claim 1, wherein the piston and the upper end of the lower housing element are displaceably and rotatably connected,

10. (Amended) The tool of Claim 9, wherein the displaceable and rotatable connection is formed by a ratchet mechanism formed with catch elements locking against, or running freely across, guides formed at the upper end of the lower housing elements, so that the lower housing element is subjected to rotation when the piston is displaced down the passage of the tool, or is without rotation when the piston is displaced back through the passage of the tool.

11. (Amended) The tool of Claim 7, wherein the lower housing element has a lower annular space arranged thereto, for fluid which is displaced from the upper annular space, and wherein the annular spaces communicate by means of channels extending between the annular spaces respectively, and wherein the flow of displaced fluid can be controlled by a check valve and a choke valve placed in the respective channels.

12. (Amended) The tool of Claim 11, wherein the lower annular space has a displaceable annular space body arranged thereto.

13. (Amended) The tool of Claim 6, wherein the valve body and the upper valve body part are formed with bores, so that a cable can be drawn through the passage of the tool.

14. (New) The tool of Claim 1, wherein the one direction rotatable connection comprises a roller bearing adapted for rotation in one direction and opposing rotation in the opposite direction in any rotational position.

REMARKS

These changes are being made to bring the subject application into better conformance with U.S. practice, to claim the benefit of previously filed international applications, and to more distinctly claim what the Applicant regards as the invention. No new matter is being introduced. Entrance of this amendment is respectfully requested. Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: 12/21/01

By: James Ausley

James W. Ausley
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AMEND
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Attached is a version with markigns to show changes. Insertions are shown **bolded** and deletions are bracketed.

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE ABSTRACT:

Abstract of the Disclosure

A tool adapted for changing the direction of drilling during drilling. The drilling equipment used in the drilling includes a drill string, a bent sub, a drill motor, and a drill bit. The tool is positioned between the drill string and the bent sub, includes housing elements connected to one another, and has a passage for drilling fluid. The tool can be activated for rotation of the bent sub so that the direction of drilling is changed in an infinitely variable manner. The tool includes a valve adapted for choking the passage so that the tool can be activated for rotation, a piston adapted for providing the rotation after passage has been choked, and sets of cooperating guides adapted for forced guiding of the rotation. The guides can be formed by twisted splines formed in the wall of the passage and in the wall of the opposite piston.

[The invention relates to a device by a tool (1) adapted for changing the direction of drilling during drilling. The drilling equipment used in the drilling preferably comprised a drill string such as coiled tubing, a bent sub, drilling motor and drill bit. The tool (1) is positioned between the drill string and the bent sub, comprises housing elements (2-5) connected to one another, and has a passage for , i.a., fluid such as drilling fluid. The tool can be activated for rotation of the bent sub, so that the direction of drilling is changed. The object to the invention is to provide a tool, whereby the rotation of the bent sub can take place in an infinitely variable manner. This is realized by means of means (18,20-24,26,27) positioned in the passage of the tool (1), and comprising a valve (20-24) adapted for choking the passage , so that the tool (1) can be activated for rotation, a piston (18) adapted for providing the rotation after the passage has been choked, and sets of co-operating guides (26,27) adapted for forced guiding of the rotation. The guides (26,27) can be formed by twisted splines formed in the wall of the passage and in the wall of the piston (18) opposite.]

IN THE SPECIFICATION:

Please amend the specification as follows:

[DEVICE BY] TOOL FOR CHANGING THE DRILLING DIRECTION WHILE DRILLING

Related Applications

This application claims the benefit of the Norwegian application 19993138 filed June 24, 1999 and the international application PCT/NO00/00213 filed June 21, 2000.

Background of the Invention

Field of the Invention

The invention relates to [device by a tool], adapted for changing the drilling direction while drilling with drilling equipment, which preferably comprises a drill string,such as coiled tubing, a bent sub, drilling motor and drill bit.

Description of the Related Art

During directional drilling of a formation in the ground, e.g. in horizontal drilling of a well, it is common to use drilling equipment, which comprises a drill string, bent sub and drill bit. The drill string may be formed of coiled tubing, and the drill bit may be hydraulically driven by the fluid circulating in the drill string. The drilling direction is changed throuhg rotation of the bent sub, and the rotation is effected by [the] **a** tool which is positioned between the lower end of the drill string and the bent sub. In known tools the rotation cannot be infinitely variable, but has to be done in invariable angular turns in the range of 15-20 degrees. This means that the drilling direction cannot be changed with the desirable accuracy. Another drawback of known tools is that the admission of the drill bit will have to be reduced to allow rotation of the bent sub The consequence of this may be that the drill bit loses its grip in the ground formation, so that instead of completing its rotation, the bent sub will return to its initial position. This is a condition which complicates and moreover delays the work of changing the drilling direction.

Summary of the Invention

The main object of the present invention is to provide a [device by a tool], whereby the rotation of the bent sub may be carried out in an infinitely variable manner. Other objects are

that the rotation should take place by full admission of the drill bit, and the rotation should take place at a speed which allows the measuring equipment to provide measurement results which are in accordance with the actual rotation. Thereby the drilling direction could be changed without the drawbacks mentioned above. Moreover, the tool will be somewhat easier to operate and provide greater precision during rotation than what has been normal. This has been realized through the present [device by a tool]adapted for changing the drilling direction during drilling. The drilling equipment used in the drilling, preferably comprises a drill string, such as coiled tubing, a bent sub, drill motor and drill bit. Further the tool is positioned between the drill string and the bent sub, comprises housing elements connected to one another, has a passage for, among other things, fluid such as drilling fluid, and may be activated for rotation of the bent sub, so that the direction of drilling is changed. The particular about the invention is that the tool is provided with means, whichare adapted so that the rotation can be infinitely variable. [Said] The means are provided in the through passage of the tool, and comprises a valeve arranged to choke the passage, so that the tool can be activated for the rotation, a piston adapted for providing the rotation after the through passage has been choked, and sets of cooperating guides adapted for forced guiding of the rotation. The guides are formed in the wall of the through passage, or in the opposite wall fo the piston. Other details of the invention will appear from the dependent Claims and the following part of the specification.

Brief Description of the Drawings

Referring to the appended set of figures, a preferred, but non-limiting embodiment of the invention will be explained,

Detailed Description of the Preferred Embodiment

In Figs. 2-4 the tool has been divided into two sections for reason of exposition, and the reference numeral s have been distributed among the figures, so that the reference numerals of one figure refer to the same detaiuls in the other figures.

Appl. No. : **Unknown**
Filed : **Herewith**

IN THE CLAIMS:

Please amend the Claims as follows:

1. (Amended) A [device by a] tool [(1)] adapted for changing the direction of drilling with drilling equipment [, which preferably comprises] **comprising** a drill string [such as coiled tubing], drill string sub, drilling engine and drill bit, wherein the tool [(1)] is positioned between the drill string and the bent sub **and wherein the tool** comprises housing elements [(2-4)], which are connected to one another, **and wherein the tool** has a passage for [, i.a.,] fluid [such as drilling fluid], and wherein the tool [(1)] is equipped with a hydraulic piston [(18)] having [been provided with] a set of co-operating guides [(26,27)] where the guides [(26,27)] are arranged for by the pistons axial displacement a forced guiding of the rotation of [one of the hosing] **a first housing** element[s (5)] with respect to the other housing elements [(2-4)], and where necessary fluid pressure for moving the piston [(18)] is obtained by choking the [pressurefluid] **fluid** flow through the tool [(1), characterized in that] **and wherein a** [the] lower intermediate housing element [(4)] and **a** [the] lower housing element [(5)] are connected by a one direction rotatable connection [(8) such as a roller bearing, adapted for only allowing rotation in one direction and opposes any rotation in the other direction at any rotational position].

2. (Amended) [A device according to] **The tool of** Claim 1, [characterized in that one] **wherein a first** set of the guides [(26)] is formed in the wall of the passage, and [one] **a second** set of the guides [(27)] is formed in the wall of the piston [(18)] opposite.

3. (Amended) [A device according to one or any of the previous claims, characterized in that said] **The tool of Claim 2, wherein the** set of guides [(26,27)] for the forced guiding of the rotation [are formed by] **comprise** twisted splines, [one] **a first** set of splines [(26)] being formed in a circumferential portion of **an** [the] upper intermediate housing element [(3)], whereas [one] **a second** set of splines is formed in a circumferential portion of the piston [(18)].

4. (Amended) [A device according to one or any of the previous claims, characterized in that the former] **The tool of Claim 3, wherein the first** set of splines [(26)] extends in a region at the upper end of the lower housing element [(5)], whereas the [latter] **second** set of splines [(27)] extends essentially in the longitudinal direction of the piston [(18)].

5. (Amended) [A device according to one or any of the previous claims, characterized in that] **The tool of Claim 1, further comprising a** [the] valve [comprises]

comprising a valve seat [(20)] formed at the upper end of a bore adapted to provide a passage through the piston [(18)] , a valve body [(21)] and a valve mechanism [(22,23,24)] adapted for choking and opening the valve by increase and relief, respectively, of the fluid pressure in the tool [(1)].

6. (Amended) [A device according to one or any of the previous claims, characterized in that] **The tool of Claim 5, wherein** the valve mechanism is formed by an upper and a lower valve body part [(22,23)] adapted for displacement along the valve body [(21)], so that the lower valve body part [(23)] can choke or open the valve, and a valve body spring [(24], wherein the upper valve body part [(22)] will displace the lower valve body part [(23)] to choke the valve when the pressure of the fluid is increased, and the valve body part spring [(24)] will displace the lower valve body part [(23)] in the opposite direction to open the valve by relief of the pressure of the fluid.

7. (Amended) [A device according to one or any of the previous claims, characterized in that] **The tool of Claim 5, wherein** the piston [(18)] is adapted to be displaced by the fluid supplied to the tool [(1)] when the valve has been choked, or be displaced in the opposite direction by a piston spring [(25)], positioned in an upper annular space [(17)], formed in the passage of the tool [(1)], after the valve has opened.

8. (Amended) [A device according to one or any of the previous claims, characterized in that said] **The tool of Claim 7, wherein** the piston [(18)] is sleeve-shaped, positioned between an upper shoulder [(14)] formed in the passage of the tool [(1)], and a shoulder element [(31)] located in the upper annular space [(17)] and formed with a length which enables the piston [(18)] to extend from the upper shoulder [(14)] into the upper annular space [(17)] located in [the] **an** extension above a lower shoulder [(15)] formed at the lower end of the upper annular space [(17)].

9. (Amended) [A device according to one or any of the previous claims, characterized in that] **The tool of Claim 1, wherein** the piston [(18)] and the upper end of the lower housing element [(5)] are displaceably and rotatably connected,

10. (Amended) [A device according to one or any of the preceding claims, characterized in that] **The tool of Claim 9, wherein** the displaceable and rotatable connection is formed by a ratchet mechanism [(28)] formed with catch elements [(30)] locking against, or running freely across, guides [(29)] formed at the upper end of the lower housing elements [(5)],

so that the lower housing element [(5)] is subjected to rotation when the piston [(18)] is displaced down the passage of the tool [(1)], or is without rotation when the piston [(18)] is displaced back through the passage of the tool [(1)].

11. (Amended) [A device according to one or any of the preceding claims, characterized in that] **The tool of Claim 7, wherein** the lower housing element [(5)] has a lower annular space [(36)] arranged thereto, for fluid which is displaced from the upper annular space [(17)], **and wherein** [that] the annular spaces [(17,36)] communicate by means of channels [(38,39)] extending between the annular spaces [(17,36)] **respectively**, and **wherein** [that] the flow of displaced fluid can be controlled by a check valve [(40) and a choke valve [(41)] placed in the respective channels [(38,39)].

12. (Amended) [A device according to one or any of the preceding claims, characterized in that] **The tool of Claim 11, wherein** the lower annular space [(36)] has a displaceable annular space body [(37)] arranged thereto.

13. (Amended) [A device according to one or any of the preceding claims, characterized in that] **The tool of Claim 6, wherein** the valve body [(21)] and the **upper** valve body part [(22)] are formed with bores, so that [,for example] a cable can be drawn through the passage of the tool [(1)].

14. (New) The tool of Claim 1, wherein the one direction rotatable connection comprises a roller bearing adapted for rotation in one direction and opposing rotation in the opposite direction in any rotational position.

WO 01/00960 PCT/NO00/00213

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JC13 Rec'd PCT/PTO 21 DEC 2001

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DEVICE BY TOOL ADAPTED TO CHANGE THE DRILLING DIRECTION WHILE DRILLING

The invention relates to a device by a tool, adapted for changing the drilling direction while drilling with drilling equipment, which preferably comprises a drill string, such as coiled tubing, a bent sub, drilling motor and drill bit.

During directional drilling of a formation in the ground, e.g. in horizontal drilling of a well, it is common to use drilling equipment, which comprises a drill string, bent sub and drill bit. The drill string may be formed of coiled tubing, and the drill bit may be hydraulically driven by the fluid circulating in the drill string. The drilling direction is changed through rotation of the bent sub, and the rotation is effected by a tool which is positioned between the lower end of the drill string and the bent sub. In known tools the rotation cannot be infinitely variable, but has to be done in invariable angular turns in the range of 15-20 degrees. This

means that the drilling direction cannot be changed with the desirable accuracy. Another drawback of known tools is that the admission of the drill bit will have to be reduced to allow rotation of the bent sub. The consequence of this may be that the drill bit loses its grip in the ground formation, so that instead of completing its rotation, the bent sub will return to its initial position. This is a condition which complicates and moreover delays the work of changing the drilling direction.

The main object of the present invention is to provide a device by a tool, whereby the rotation of the bent sub may be carried out in an infinitely variable manner. Other objects are that the rotation should take place by full admission of the drill bit, and the rotation should take place at a speed which allows the measuring equipment to provide measurement results which are in accordance with the actual rotation. Thereby the drilling direction could be changed without the drawbacks mentioned above. Moreover, the tool will be somewhat easier to operate and provide greater precision during rotation than what has been normal. This has been realized through the present device by a tool adapted for changing the drilling direction during drilling. The drilling equipment used in the drilling, preferably comprises a drill string, such as coiled tubing, a bent sub, drill motor and drill bit. Further the tool is positioned between the drill string and the bent sub, comprises housing elements connected to one another, has a passage for, among other things, fluid such as drilling fluid, and may be activated for rotation of the bent sub, so that the direction of drilling is changed. The particular about the invention is that the tool is provided with means, which is adapted so that the rotation

can be infinitely variable. Said means is provided in the through passage of the tool, and comprises a valve arranged to choke the passage, so that the tool can be activated for the rotation, a piston adapted for providing the rotation after the through passage has been choked, and sets of co-operating guides adapted for forced guiding of the rotation. The guides are formed in the wall of the through passage, or in the opposite wall of the piston. Other details of the invention will appear from the dependent Claims and the following part of the specification.

Referring to the appended set of figures, a preferred, but non-limiting embodiment of the invention will be explained,

Fig. 1 showing a schematic view of longitudinal sections through the tool in three typical positions, i.e. a non-activated position with the passage open to fluid, and activated position, with the passage choked before the rotation has been started, and by completed rotation, respectively;

Fig. 2 showing a schematic view of a longitudinal section through a tool in the non-activated position with the passage open to fluid;

Fig. 3 showing the same schematic view as Fig. 2, but with the tool in the activated position with the passage for fluid choked, so that the tool has been prepared for the rotation;

Fig. 4 showing the same schematic view as Fig. 1, but with the activated tool in an end position, by full turn during the rotation, and:

Fig. 5 showing a schematic view of a section in the transversal direction through the ratchet mechanism when the tool is in the positions mentioned above.

In Figs. 2-4 the tool has been divided into two sections for reason of exposition, and the reference numerals have been distributed among the figures, so that the reference numerals of one figure refer to the same details in the other figures.

The tool 1 is made up of housing elements 2, 3, 4, 5 which are connected to one another, and are formed with bores, so that the tool 1 will have a passage for well fluid, among other things. The drill string is fixed to an upper end of the upper housing element 2, and the bent sub is fixed to the lower end of the lower housing element 5. The connections between the housing elements 2, 5, the drill string and the bent sub may, for example, be threaded connections. The upper end of the upper intermediate housing element 3 is fixed to the lower end of the upper housing element 2. The bore of the intermediate housing element 3 has such a fit that the lower end of the upper housing element 2 can be inserted a distance into the intermediate housing element 3. The connection 6 between the housing elements 2, 3 may, for example, be a threaded connection, and it is made pressure-tight by means of a seal 9 provided in the fit between the housing elements 2, 3. The lower end of the upper intermediate housing element 3 is fixed to the upper end of the lower intermediate housing element 4. The bore of the lower end of the upper intermediate housing element 3 has such a fit that the upper end of the lower housing element 5 can be inserted a distance into the upper intermediate housing element 3. The connection 7 between the housing elements 3, 4 may, for example, be a

threaded connection, and it is made pressure-tight in that a seal 10 is placed in the fit between the housing elements 3, 4. The lower intermediate housing element 4 is rotatably connected to the lower housing element 5. The connection 8 is such that rotation is only allowed in the negative direction, namely opposite the direction of rotation of the bent sub, and may be a roller bearing, for example. It has been made pressure-tight by means of a seal 11 positioned in the fit between the housing elements 4, 5. Moreover, the bore of the lower intermediate housing element 4 is adapted so, that the lower intermediate housing element 4 will be placed externally on, and a distance up from, the lower end of the lower housing element 5. Besides, a thrust bearing is positioned between the upper end of the bearing 8 and an inward shoulder of the intermediate housing element 4.

As mentioned, the lower end of the upper housing element 2 and the upper end of the lower intermediate housing element 4 are inserted into the bore of the upper intermediate housing element 3, and therefore the end surfaces thereof form an upper shoulder 14 in the through passage of the tool 1, and a lower shoulder 30 in an upper annular space 17, respectively. Further, the lower housing element 5 is formed with a length, which makes the lower housing element 5 extend a relatively long distance into the upper intermediate housing element 3. The bore of the upper intermediate housing element 3 moreover has such a wide fit that the upper annular space 17 is formed between the upper intermediate housing element 3 and the part 16 of the lower housing element 5, which extends past the lower shoulder 30.

The tool 1 is provided with a sleeve-shaped piston 18, which is positioned below the upper shoulder 14 of the tool. The piston 18 has a length which allows the piston 18 to extend from the upper shoulder 14, past the upper end of the lower housing element 5 into the upper annular space 17. The fit between the piston 18 and the upper end of the lower housing element 5 is made pressure-tight by means of a seal 13. The piston 18 is formed, correspondingly to the housing elements 2, 3, 4, 5, with a bore, so that the piston 18 does not block the passage of the tool 1. At its upper end, the piston 18 has a valve arranged thereto, with a valve body 21 which may be moved towards a valve seat 20, so that the valve can choke the passage of the tool 1. The valve body 21 is connected to the piston 18 by means of a support element 19 positioned at the upper end of the bore of the piston 18. The support element 19 is formed so that fluid may pass.

The valve is choked as the valve body 21 is about to be seated on the valve seat 20. In the present case the valve is choked by a pressure increase in the fluid passing through the tool. The valve mechanism comprises upper and lower valve body parts 22, 23 which are formed to allow displacement along the valve body 21 in order to choke, or open, the valve. By means of the spring force of a valve body spring 24, the lower valve body part 23 is retained in a first end position, in which the valve is open for fluid to pass. If the pressure in the passing fluid is increased, the fluid will make the lower valve body part 23 be displaced by the upper valve body part 22 into a second end position in which the valve is choked, so that there will be a pressure drop in the fluid passing through the valve. When the pressure of the fluid is relieved, the spring force of the valve body spring

24 will open the valve by displacing the lower valve body part 23 and the upper valve body part 22 into the first end position. It is obvious that the valve can have different construction from the one shown in the set of figures, e.g. be formed with a fixed choking. The valve body part 21 and the upper valve body part 22 may have bores, so that a cable placed in the passage may be drawn through the valve.

As a consequence of the pressure drop across the valve, the fluid which is supplied to the tool 1 when the valve has been choked, will cause the piston 18 to be driven from a first end position, in which the upper end of the piston 18 rests on the upper shoulder 14, into a second end position, in which the lower end of the piston 18 has compressed a piston spring 25 positioned in the upper annular space 17. The spring force of the compressed piston spring 25 will cause the piston 18 to be driven back into abutment on the upper shoulder 14 when the valve is reopened by reduction of the fluid pressure. At its lower end, the piston spring 25 rests on a shoulder element 31 located in the upper annular space 17 above the lower shoulder 30. Between the shoulder 30 and the shoulder element 31 is placed a lower thrust bearing 32, disc springs 33, a support element 34 which is retained in position by a locking mechanism 35, and an upper thrust bearing 35. The locking mechanism 35 is somewhat recessed in the side wall of the part 16 of the lower housing element 5 facing inwards towards the upper annular space 17.

Fluid will be displaced from the upper annular space 17 during rotation. When being displaced, this fluid is led to a lower annular space 36, which is formed in the passage of the tool at the lower end of the lower housing element 5. The

lower annular space 36 is sealed by means of a displaceable annular space body 37, which has been made pressure-tight by means of seals 42, 43. The annular space body 37 is displaced down the lower annular space 36 by fluid which is displaced from the upper annular space 17, and it is displaced up the lower annular space 36 by the fluid in the passage after the valve has opened. Alternatively the upward displacement may take place by means of a spring not shown, which is placed in the lower annular space 36 below the annular space body 37. Channels 38, 39 provide passage from the upper annular space 17 to the lower annular space 36. One of the channels 38 is sealed towards the upper annular space 17 by means of a check valve 40, and the other one of the channels 39 is sealed towards the upper annular space 17 by means of a choke valve 41. Said valves 40, 41 are placed in the lower shoulder 30. Additionally, the thrust bearings 32, 36, the spring discs 33 and the support section 34 are arranged so, that the fluid which is displaced during rotation, may pass.

To provide forced rotation of the lower housing element 5, which is connected to the bent sub, concurrently with the piston 18 being displaced in the passage of the tool 1, a circumferential portion of the bore of the upper intermediate housing element 3, preferably in the region at the upper end of the lower housing element 5, and a circumferential portion of the piston 18, preferably along the major part of the length of the piston 18, are formed with guides 26, 27 such as twisted splines. Further, the piston 18 is rotatably and displaceably connected to the upper end of the lower housing element 5. This rotatable and displaceable connection may be formed by a ratchet mechanism 28, arranged so that it can be displaced along a number of guides 29. The guides 29 are

positioned at the upper end and on that side of the lower housing element 5, which faces the upper annular space 17. Moreover, the guides 29 preferably extend along large parts of the wall in, and preferably parallel to, the longitudinal direction of the upper annular space 17. The catch elements 30 of the ratchet mechanism will bear in a locking manner against the guides 29, so that rotation of the lower housing element 5 in the negative direction is prevented during the rotation of the bent sub, but rotation is allowed in the opposite direction when the piston 18 returns after completed rotation.

The present invention will allow the rotation of the bent sub to be infinitely variable. Through reduction of the fluid pressure, so that the valve of the piston 18 opens the fluid passage, the rotation may moreover be interrupted when the desired turn has been reached. By greater turns, the rotation takes place in that the valve of the tool 1 is choked, opened, choked etc. until the bent sub is in the desired position. The ratchet mechanism 28 connecting the piston 18 and the lower housing element 5, will help to allow the drill bit to be driven by full admission. When the piston spring 25 carries the piston 18 back into its initial position in abutment on the upper shoulder 14 after the opening of the valve, the ratchet mechanism 28 and the rotatable connection 8 will provide for the piston 18 to rotate in the opposite direction. At the same time the lower housing element 5 remains stationary without rotation. It should be mentioned that the ratchet mechanism 28 and the rotatable connection 8 may be replaced by connections which are locked mechanically.

The displacing mechanism works in the way that the choke valve 41 opens when the tool is activated for rotation, so that the fluid may be displaced from the upper annular space 17 into the lower annular space 36 through the channel 39. At the same time the annular space piston body 37 is displaced down the lower annular space 36 by displaced fluid. When the rotation is completed, the fluid will return to the upper annular space 17 through the channel 38 as the annular space body 37 is being displaced upwards in the lower annular space 36 by the fluid flowing through the tool. By adjustment of the choking of the choke valve 41, the speed of rotation of the tool may be controlled, so that the measuring equipment mentioned above will be able to provide measuring results, which are in accordance with the actual rotation provided by the tool 1.

The description will be concluded by a brief review of the operation of the present tool. As mentioned, Fig. 2 shows the tool 1 in a non-activated position during the drilling. The valve is then open, so that fluid circulating in the drill string can pass unobstructedly through the tool 1. The tool 1 is activated for rotation by increasing the pressure of the fluid passing through the tool 1. The increased fluid pressure displaces the upper valve body part 22 down along the valve body 21, so that the lower valve body part 23 is carried into a position in abutment on the valve seat 20. Thereby the valve is choked. Due to the pressure drop across the choked valve, the fluid, which is supplied to and passes through the tool 1 after the valve has been choked, will displace the piston 18 down the passage of the tool 1. Thereby the guides 26, 27 will force a rotation on the piston 18, guided by the curvature of the guides 26, 27. During the

displacement of the piston 18 down the tool 1, the catch elements 30 of the ratchet mechanism 28 abut, and are at the same time moved down along, the guides 29 of the upper part of the lower housing element 5, so that the lower housing element 5 fitted with a bent sub rotates to provide a change of the direction of drilling. The speed of rotation may, as earlier mentioned, be controlled by means of the choking of the choke valve 41 of the channel 39 between the annular spaces 17, 36.

The rotation ends by relief of the pressure of the fluid. Consequently, the spring force of the valve body spring 24 will exceed the fluid pressure and displace the lower valve body part 23 up along the valve body 21, so that the valve opens. When the valve is open, the spring force of the compressed piston spring 25 in the annular space 17 will displace the piston 18 up the passage of the tool 1. During the return movement of the piston 18, the catch elements 30 of the ratchet mechanism 28 will allow rotation of the piston 18, whereas the lower housing element 5 remains in a position, in which the housing element 5 does not rotate. Similarly, the rotatable connection 8 between the housing elements 4, 5 will contribute to the same, if the ratchet mechanism cannot fully manage to take care of the rotation returning the piston 18. By major changes of direction the above-mentioned cycle is repeated until the desired turning of the bent sub has been reached.

Claims

1. A device by a tool (1) adapted for changing the direction of drilling during drilling with drilling equipment, which preferably comprises a drill string such as coiled tubing, drill string sub, drilling engine and drill bit, wherein the tool (1) is positioned between the drill string and the bent sub, comprises housing elements (2-4), which are connected to one another, has a passage for, i.a., fluid such as drilling fluid, and wherein the tool (1) is equipped with a hydraulic piston (18) having been provided with a set of co-operating guides (26, 27) where the guides (26, 27) are arranged for by the pistons axial displacement a forced guiding of the rotation of one of the hosing elements (5) with respect to the other housing elements (2-4), and where necessary fluid pressure for moving the piston (18) is obtained by choking the pressurefluid flow through tool (1), characterized in that the lower intermediate housing element (4) and the lower housing element (5) are connected by a one direction rotatable connection (8) such as a roller bearing, adapted for only allowing rotation in one direction and opposes any rotation in the other direction at any rotational position.

2. A device according to claim 1, characterized in that one set of the guides (26) is formed in the wall of the passage, and one set of guides (27) is formed in the wall of the piston (18) opposite.

3. A device according to one or any of the preceding claims, characterized in that said set of guides (26, 27) for the forced guiding of the rotation are formed by twisted splines, one set of splines (26) being formed in a circumferential portion of the upper intermediate housing element (3), whereas one set of splines (27) is formed in a circumferential portion of the piston (18).

4. A device according to one or any of the preceding claims, characterized in that the former set of splines (26) extends in a region at the upper end of the lower housing element (5), whereas the latter set of splines (27) extends essentially in the longitudinal direction of the piston (18).

5. A device according to one or any of the preceding claims, characterized in that the valve comprises a valve seat (20) formed at the upper end of a bore adapted to provide a passage through the piston (18), a valve body (21) and a valve mechanism (22, 23, 24) adapted for choking and opening the valve by increase and relief, respectively, of the fluid pressure in the tool (1).

6. A device according to one or any of the preceding claims, characterized in that the valve mechanism is formed by an upper and a lower valve body part (22, 23) adapted for displacement along the valve body (21), so that the lower valve body part (23) can choke or open the valve, and a valve body spring (24), wherein the upper valve body part (22) will displace the

lower valve body part (23) to choke the valve when the pressure of the fluid is increased, and the valve body spring (24) will displace the lower valve body part (23) in the opposite direction to open the valve by a relief of the pressure of the fluid.

7. A device according to one or any of the previous claims, characterized in that the piston (18) is adapted to be displaced by the fluid supplied to the tool (1) when the valve has been choked, or be displaced in the opposite direction by a piston spring (25), positioned in an upper annular space (17), formed in the passage of the tool (1), after the valve has opened.

8. A device according to one or any of the previous claims, characterized in that the piston (18) is sleeve-shaped, positioned between an upper shoulder (14) formed in the passage of the tool (1), and a shoulder element (31) located in the upper annular space (17), and formed with a length which enables the piston (18) to extend from the upper shoulder (14) into the upper annular space (17) located in the extension above a lower shoulder (15) formed at the lower end of the upper annular space (17).

9. A device according to one or any of the previous claims, characterized in that the piston (18) and the upper end of the lower housing element (5) are displaceably and rotatably connected.

10. A device according to one or any of the previous claims, characterized in that the displaceable and

rotatable connection is formed by a ratchet mechanism (28) formed with catch elements (30) locking against, or running freely across, guides (29) formed at the upper end of the lower housing element (5), so that the lower housing element (5) is subjected to rotation when the piston (18) is displaced down the passage of the tool (1), or is without rotation when the piston (18) is displaced back through the passage of the tool (1).

11. A device according to one or any of the previous claims, characterized in that the lower housing element (5) has a lower annular space (36) arranged thereto, for fluid which is displaced from the upper annular space (17), that the annular spaces (17, 36) communicate by means of channels (38, 39) extending between the annular spaces (17, 36), and that the flow of displaced fluid can be controlled by a check valve (40) and a choke valve (41) placed in the respective channels (38, 39).

12. A device according to one or any of the previous claims, characterized in that the lower annular space (36) has a displaceable annular space body (37) arranged thereto.

13. A device according to one or any of the previous claims, characterized in that the valve body (21) and the valve body part (22) are formed with bores, so that, for example, a cable can be drawn through the passage of the tool (1).

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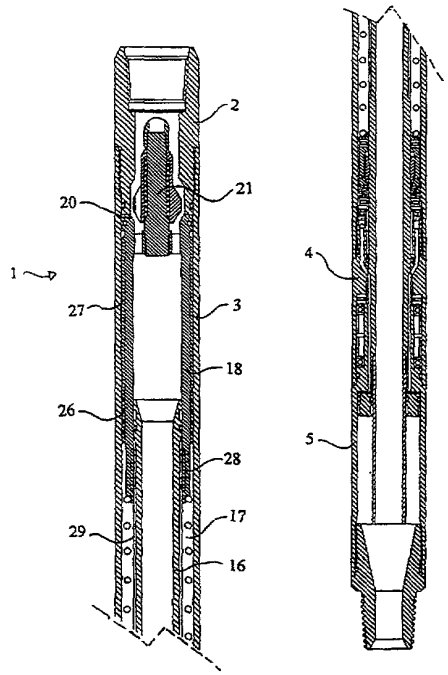
(54) Title: DEVICE BY TOOL ADAPTED TO CHANGE THE DRILLING DIRECTION WHILE DRILLING



(57) Abstract: The invention relates to a device by a tool (1) adapted for changing the direction of drilling during drilling. The drilling equipment used in the drilling preferably comprises a drill string such as coiled tubing, a bent sub, drilling motor and drill bit. The tool (1) is positioned between the drill string and the bent sub, comprises housing elements (2-5) connected to one another, and has a passage for, i.a., fluid such as drilling fluid. The tool can be activated for rotation of the bent sub, so that the direction of drilling is changed. The object of the invention is to

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Fig. 1

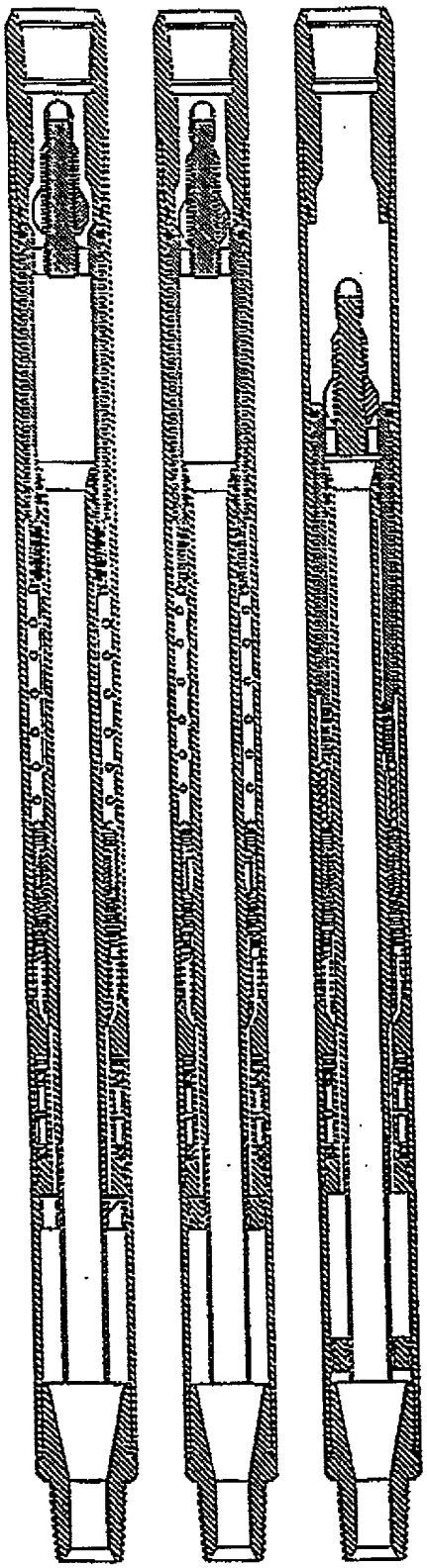

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Fig. 2

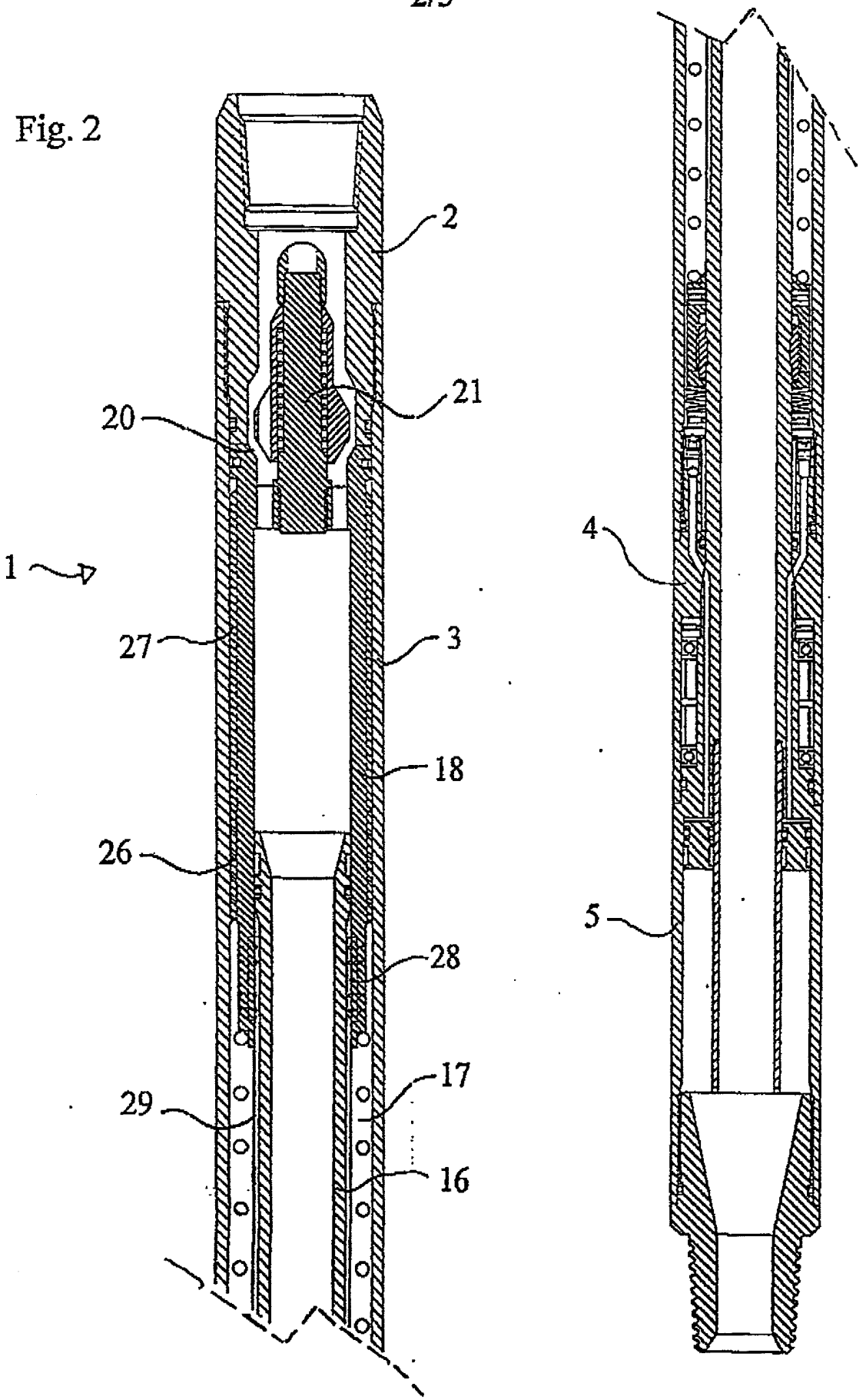

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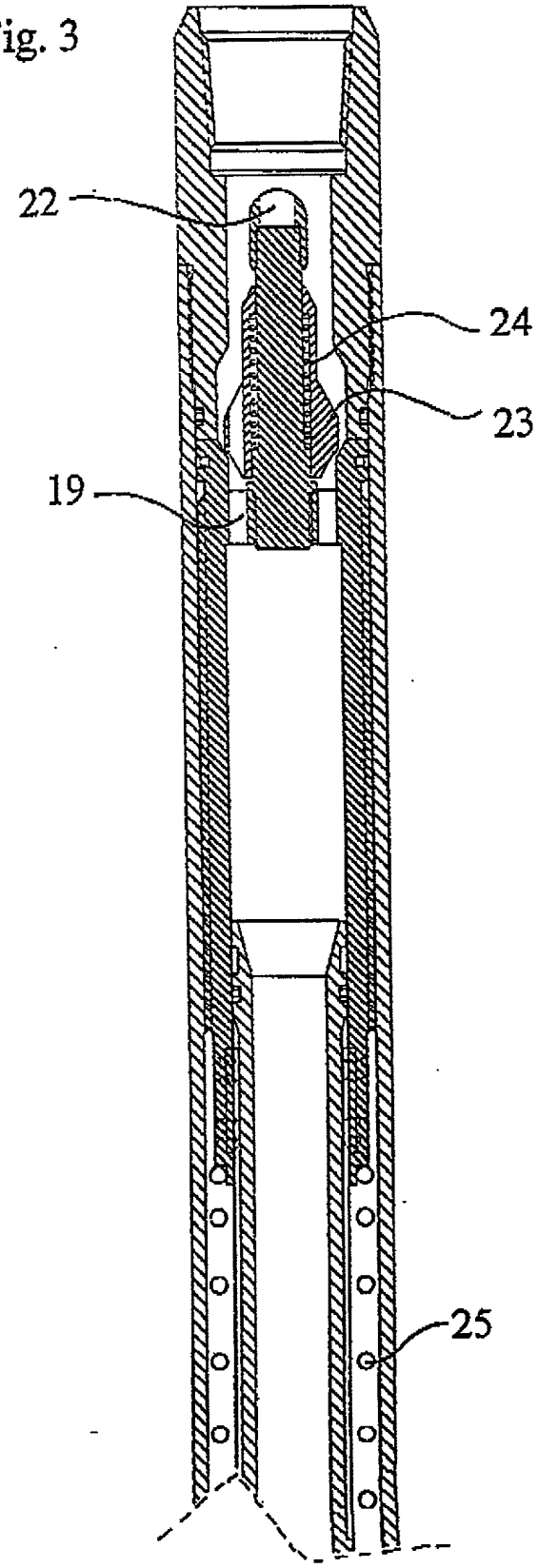
Fig. 3



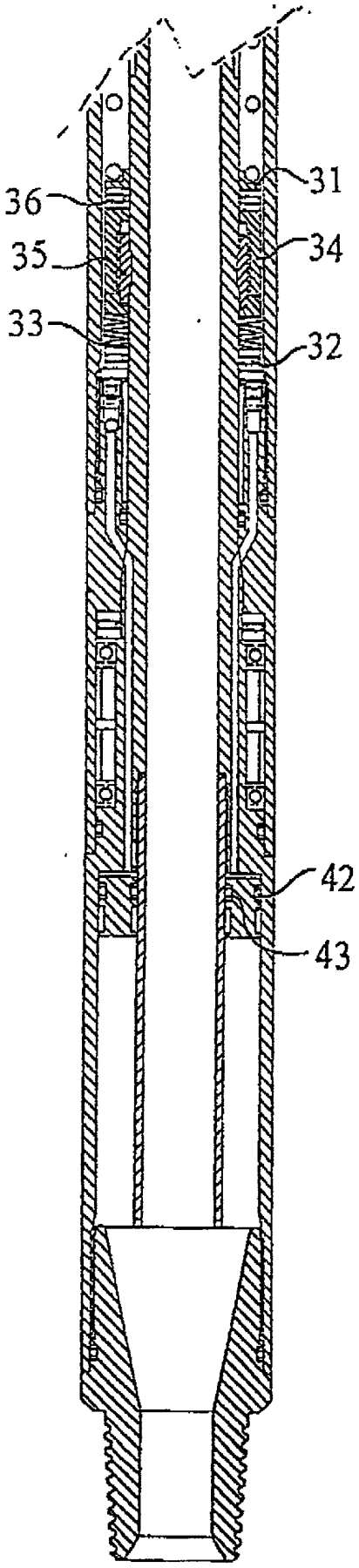
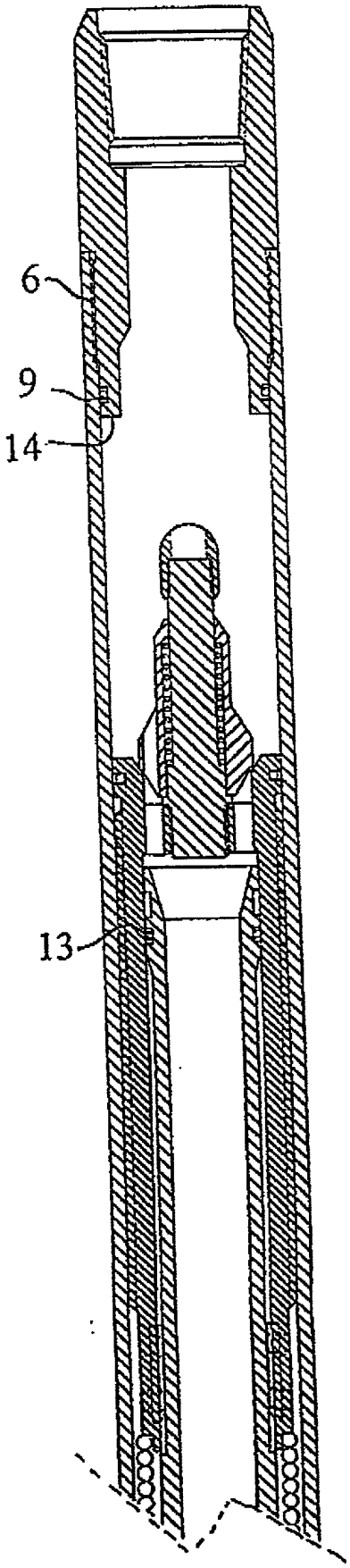


Fig. 4



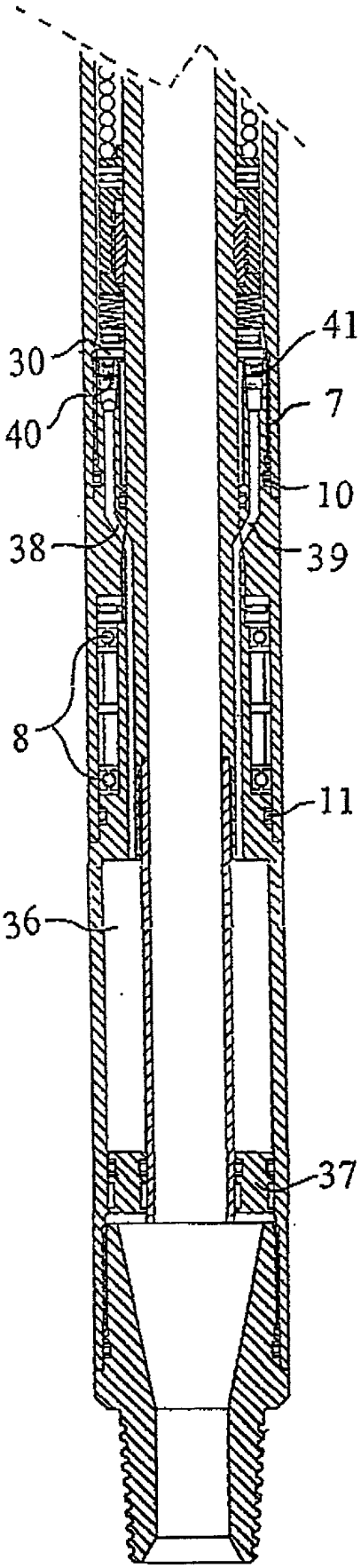
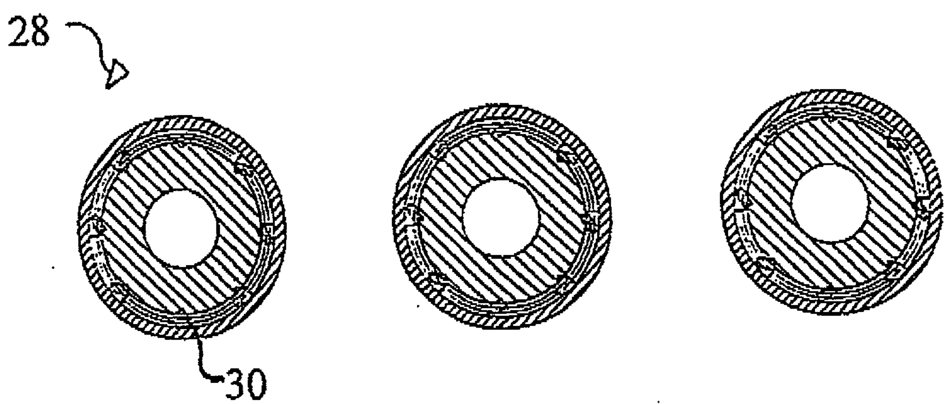


Fig. 5



PATENT

ESTABLISHMENT OF RIGHT OF ASSIGNEE TO TAKE ACTION AND REVOCATION AND POWER OF ATTORNEY

To the Commissioner of Patents and Trademarks:

The undersigned is empowered to act on behalf of the assignee indicated below (the "Assignee"). The original assignment of the attached application for Letters Patent for the invention in TOOL FOR CHANGING THE DRILLING DIRECTION WHILE DRILLING from the inventors to the Assignee is being submitted herewith for recordation by the Assignment Branch. A true copy of this Assignment is attached hereto. This Assignment represents the entire chain of title of this invention from the Inventor(s) to the Assignee. I have reviewed this Assignment, and to the best of the Assignee's knowledge and belief, the Assignee is the owner of the entire right, title, and interest in the above-referenced application.

I declare that all statements made herein of my own knowledge are true, and that all statements made upon information and belief are believed to be true, and further, that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001, and that willful, false statements may jeopardize the validity of the application, or any patent issuing thereon.

The undersigned hereby revokes any previous powers of attorney in the subject application, and hereby appoints the registrants of Knobbe, Martens, Olson & Bear, LLP, 620 Newport Center Drive, Sixteenth Floor, Newport Beach, California 92660, Telephone (949) 760-0404, Customer No. 20,995, as its attorneys with full power of substitution and revocation to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected herewith. This appointment is to be to the exclusion of the inventor(s) and his attorney(s) in accordance with the provisions of 37 C.F.R. § 3.71.

Please use Customer No. 20,995 for all communications.

Assignee: Bakke Technology AS

By: Stig Bakke

Title: Manager

Address: 4330 Ålgård Norway

Dated: 23/4-02

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 Attorney's Docket No: HAMSO21.001APC

DECLARATION - USA PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled TOOL FOR CHANGING THE DRILLING DIRECTION WHILE DRILLING the specification of which:

(a) o is attached hereto; or

(b) X was filed on December 21, 2001 as Application No. 10/030413 or Express Mail No., as Application No. not yet known _____ and was amended on _____ (if applicable); or

(c) o was described and claimed in PCT International Application No. _____ filed on _____ and as amended under PCT Article 19 on _____ (if any) and/or under PCT Article 34 on _____ (if any).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above;

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56;

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent, design or inventor's certificate or any PCT international application(s) listed below and have also identified below any foreign application(s) for patent, design or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed for the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 37 U.S.C. § 119	
Norway	19993138	June 24, 1999	X YES	NO o
PCT	PCT/NO00/00213	June 21, 2000	X YES	NO o
			o YES	NO o
			o YES	NO o
			o YES	NO o

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below, and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Prior U.S.A. Application(s)

Application No.: _____ Filing Date: _____ Status: _____

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful, false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: Stig Bakke

Inventor's signature _____ Day 23 Month April Year 2002

Residence (city and country): Neslaberget 9, N-4330 Ålgård, NORWAY NO

Citizenship: Norwegian

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